Development of Living Labs to support Gendered Energy Technology Innovation in Poor Urban Environments

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Abstract

Working together with end-users and different private and public stakeholders towards a common goal in a real-life setting creates a rich environment for co-design, co-creation, co-innovation and sharing of different ideas in an iterative fashion. Such spaces are termed Living Labs. This paper builds on the understanding of Living Labs and explores the best application of the concept to support gendered energy technology innovation in poor urban environments. Using a case study of a poor urban informal environment in South Africa, this paper describes the implementation of the Living Lab concept in seeking security of energy services in the household energy sector and the roles of the identified stakeholders towards operationalisation of the Lab. Living Labs are dynamic innovation spaces that consider a multidimensional approach (technical, economic, usability, regulative, environmental, social, etc.) to problem solving and ease future implementation and diffusion of solutions, technologies, and innovations, if managed well.

Keywords: Energy Innovation; Living Labs; Gender Mainstreaming; South Africa; Co-innovation; Urban Slums

1. Introduction

There is increasing realisation of the significance of involving users and collaborations between designers and end-users in the co-production of content and innovations (Ballon et al., 2005; Dutilleul et al., 2010; Almirall et al., 2012; Dell'Era & Landoni, 2014). The collaborations result in a network that provides for co-creation, user engagement, testing and experimentation facilities targeting innovations in different domains such as energy, media, mobility, healthcare, agri-food, etc. The collaborations can take one of two forms, namely (i) where users are the lead innovators or open-source communities (von Hippel, 2001), and (ii) where users are collaborative partners involved in co-creation (Brown, 2008). The involvement of users as co-creators on the same level as all other participants and experimentation in real world settings, is termed "Living Labs" (Almirall et al., 2012).

According to the European Network of Living Labs (ENoLL)[1], Living Labs are defined as "*user-centred, open innovation ecosystems based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings."* The origin of Living Labs can be traced back to the first social experiments in Scandinavian countries in the seventies and eighties (Ballon et al., 2005). The modern concept of 'Living Labs' is however accredited to Prof W.J. Mitchell[2] that suggested wiring 'living' spaces such as a building/city to monitor people's responses to/or interactions with innovations (Dutilleul et al., 2010). The official launch of European Living Labs was in 2006 by the Finnish Presidency to enable more effective leverage of public investment in research (Dutilleul et al., 2010; Burbridge, 2017). Although historically concentrated to technological advancements, Living Labs today have found application in almost all fields, including social research systems (Ahmadi et al., 2020), hence at times called 'Social Innovation Spaces' (Edwards-Schachter et al., 2012). Dell'Era & Landoni (2014) emphasized three aspects that are peculiar to Living Labs: (i) the potential to co-create, (ii) the awareness of the users, and (iii) real life setting. One of the distinct aspects of Living Labs is that users are involved in the innovation at a very early stage of its development and become the centre as well as potential main drivers of the technologies (Almirall et al., 2012). This enables early capture of local knowledge, experiences, preferences and needs of the target group.

Living Labs act as intermediaries among researchers, the community, the government, companies, cities, and organisations, where value is rapidly co-created, prototyped and scaled

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up for commercialisation (Almirall et al., 2012; Dupont et al., 2017). These different organs working in a common space make up the stakeholders of the Living Lab. Successful Living Labs act as examples to society, the government and private sector on how collaborations between knowledge creators and users results in evidence-based solutions to societal needs (Burbridge, 2017; Dupont et al., 2017). These creative spaces enable (Dell'Era & Landoni, 2014):

(i) Development of more context-specific insights with the users, easing the acceptance process,

(ii) The experimentation phase acts as a stimulation for adoption and shows the economic conditions that will affect, for example a technology,

(iii) With the technology in a living space, images of potential societal impacts of innovation can be easily seen.

This paper advances the understanding of Living Labs and explores the best application of the concept to support gendered energy technology innovation in poor urban environments. Currently, there is limited application of the concept of Living Labs in the energy space and on the African continent. Living Labs have been applied more widely in ICT, environment, and the health sector for instance. Gendered energy technology innovation means bridging gender awareness into consciousness and daily innovations in energy technologies to ensure universal access of energy services to all (Musango et al., 2020). Musango et al. (2020) also define poor urban environments as "*spatial locations with a concentration of urban dwellers who are deficient of something specified, both in quantity and quality, and are unable to meet a need or requirement or service fully"*. In this case, what is referred to as the "something specified" is household energy services. This study therefore explores the following questions: (i) What are the understandings and interpretations/typologies of the concept of Living Lab in the literature? (ii) How can the Living Lab concept be adapted to support the gendered energy technology innovation in poor urban environments? (iii) What are the behaviours expected of stakeholders influencing gendered energy technology innovation in the Living Lab and what are their potential roles in the context of mainstreaming Gender for Energy Security in poor urban environments in short Gender for Energy Security (GENS) Living Labs? The Africa-UK Trilateral Research Chair, Mainstreaming Gender for Energy Security in Poor Urban Environments, is a Stellenbosch University Tier 1 Africa-UK Trilateral Research Chair. The overall objective of the GENS Trilateral Chair is to build research capacity and produce knowledge across Africa

concerning gender-informed innovation and commercialization opportunities in alternative energy technology and services. The GENS will explicitly contribute to the energy-gender-poor urban nexus research, with two Living Labs, one in South Africa and the other in Kenya. The next sections of the paper give a description of the understanding of Living Labs including the general structure. It attempts to answer our first and second research question on the interpretations of Living Labs in literature and how the Living Labs concept can be adapted to support the gendered energy technology innovation in poor urban environments. Section four explores stakeholders and their roles within Living Labs with specificity to the GENS Living Labs and then concluding remarks and way forward for the GENS Living Labs is stated.

2. Methodological approach

This paper uses a narrative literature review and a case study of the GENS Living Lab in South Africa (Groenheuwel) to understand the general concept of Living Labs and suggest ways to apply the best practices of Living Labs in the case study. Groenheuwel is a continually transforming urban informal settlement (Sias, 2012) in the Drakenstein Municipality, Cape Winelands District, Western Cape, South Africa. The area grows rapidly due to rural-urban migration and new family formations make planning difficult (IDP 2017 – 2022). The community has a low socio-economic profile, characterised by energy, financial and food insecurity, violence, drug, and alcohol abuse (Bernhardt, 2012; Mukama et al (submitted)). Literature was searched and summarised from Scopus, Google scholar and websites of existing Living Labs that define and provide context on Living Labs and their operationalisation. The specific search words included: ‘Living Labs’, ‘energy Living Labs’, ‘gendered Living Labs’, ‘Living Labs in Africa’, ‘Living Labs in poor urban environments’, ‘stakeholders’, ‘stakeholders in Living Labs’, ‘energy stakeholders’, ‘stakeholders in poor urban environments.' From the various search results, aspects applicable to this case study and literature that gives context to the study research questions were considered. The next section attempts to answer research question one and two.

3. State of the art of the Living Labs concept and application to GENS Living Labs

Living Labs is an umbrella concept that has been defined uniquely for different scenarios, however it generally encompasses conducting a study, observing, and building innovations within a real-life everyday environment, like a community, school, or hospital. In that way,

technologies and innovations get to be more embedded and highly visible in society, thereby improving their societal impact (Ballon et al., 2005; Hossain et al., 2019). Scholars have defined the term Living Lab differently, for example Dell'Era & Landoni (2014) compiled 13 definitions for the term Living Labs. Dell'Era & Landoni (2014) found that all the definitions included two major concepts: "real-life experimentation environment" and "the involvement of users in the co-creation". They however argued that the definitions failed to highlight the original new product development approach implied by the Living Lab methodology hence defining Living Labs as "*a design research methodology aimed at co-creating innovation through the involvement of aware users in a real-life setting*". Hossain et al. (2019) recently carried out a systematic review of literature on Living Labs. The authors deduced the Living Lab to "*a physical or virtual space in which to solve societal challenges, especially for urban areas, by bringing together various stakeholders for collaboration and collective ideation*". This definition highlights the role of stakeholders in the Living Lab and the benefits of collaboration, however, the mention of "especially for urban areas" does not add value to the definition as Living Labs can be set up in any setting, rural or urban, as long as there is a collection of willing stakeholders working together to solve a particular societal challenge within a real-life setting (Almirall et al., 2012).

Living Labs can be seen as 'vehicles' or a 'flexible methodological framework' towards attainment of a particular goal (Ahmadi et al., 2020). This flexibility enables different designs of the Labs to suit the tasks at hand. The best context for the Living Lab is based on the knowledge that Living Labs seek from the users (Almirall et al., 2012). In the case of marginalised and vulnerable groups in our societies, like the chronically sick, disabled, Ahmadi et al. (2020) argued that Living Labs act as 'safe spaces' to voice their own opinions, address own concerns and offer possibilities to evoke change. Participants in such spaces can also get over their fears and stereotypes, cultivating open and creative minds to create and exchange ideas that would be missed in the absence of these creative settings (Ahmadi et al., 2020). Living Lab methodologies can be divided into four different categories (Almirall et. al., 2012):

(i) user centred – where the users are majorly passive participants. This mainly happens in ethnographic research, usability testing of say a new technology and studies related to how human factors affect technologies,

(ii) design driven – where designers of new technologies mainly drive process in real life environments,

(iii) participatory – where all participants take part on equal basis in a co-creative process, and

(iv) user driven – where the users are the main drivers of the innovation process.

The concept of Living Labs has wide scale applications in almost any field, if there is need for participatory action research or design (Hossain et al., 2019). For example, in the field of research, specifically on innovations in literature search by researchers, Schaer et al. (2020) defined a Living Lab as "*a user-centric study methodology for researchers to evaluate the performance of retrieval systems within real-world applications*." In this case, the users are the researchers themselves improving the 'literature search' experience and results. In relation to social change, Ahmadi et al. (2020) described Living Labs as "*co-creative 'social innovation hubs' aimed at social change, including a multiplicity of stakeholders and show a certain flexibility with regard to setup (including epistemology, methodology and method*)." This definition also includes 'stakeholders' who are the key drivers of the process and mentions the aspect of flexibility of the methodology, as living labs should be spaces that cultivate creativity of all those involved. The other very important aspect to consider for a Living Lab is time (Ahmadi et al., 2020). A long-term sustained engagement enables enough time for the outcomes from the Living Lab to positively impact the users and beyond (Dupont et al., 2019; Ahmadi et al., 2020). Success of the Living Lab also involves tailoring methodologies and strategy to the local situation (Guzzman et al., 2008). From the different examples of definitions above, it can be deduced that the term Living Labs can be suited to the scenario under investigation if it includes "real-life experimentation environment" and "the involvement of users in the co-creation". These will be the two main principles that will be applied in the GENS Living Labs.

3.1. Structure of a Living Lab

Living Labs are viewed as landscapes, methodologies, real-life environments, where different stakeholders apply different methods, tools, and models to achieve predefined goals (Hossain et al., 2019). However, the benefits from Living Labs are threatened by unpredictability of outcomes, the sustainability of the project, say after the end of funding period and handover to the community, scalability of the outcomes, and challenges of recruiting the users (Yun et al., 2019). Research in Living Labs usually follows an iterative cyclic process (Ahmadi et al., 2020) as in **Fig. *1***

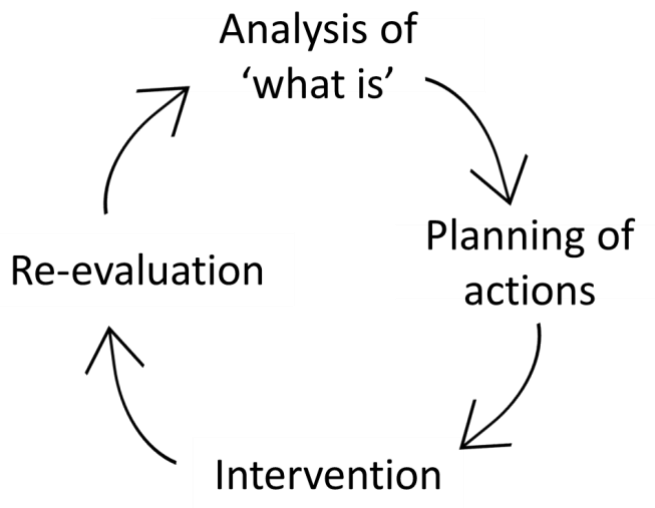

Fig. 1 Typical process of research in a Living Lab (Ahmadi et al., 2020)

At the initial stage of analysing "what is', information from the study can be obtained through interview transcripts, field notes, notes about informal talks and documented workshop results (Ahmadi et al. 2020). Interviews and observations at the initial phase of the study enable a richer understanding of the study context and gives a voice to the participants in the Living Lab (Dupont et al., 2017; Ahmadi et al., 2020). With this information, the stakeholders in the Living Lab then together plan the next steps of action, intervene, guided by the planned course of action, and then evaluate and re-evaluate the results of their actions. This being a cyclic process, goes on until the stakeholders are satisfied with the process. With a similar course of action, Almirall et al. (2012) described a Living Lab methodology called 'FormIT'. It is an iterative process that ends up with end products and services refined to user needs. It is, for example, the method used by TestBed Botnia Living Lab that focussed on mobile services at the Centre for Distance-Spanning Technology[3]. 'FormIT' is a Living Lab methodology with three stages; (1) design of concept, (2) design of prototypes, and (3) design of systems (Almirall et al., 2012). In the initial phase, participants give rich narratives of "what is" and dream of "what could be" in real-life settings, generating initial concepts. These are then ranked based on needs and priorities. Priorities are elevated for the next stage of prototyping, that involves build of mock-ups, while in the final stage, users test and evaluate the prototypes in real-life contexts (Almirall et al., 2012).

[3] Research centre in the Luleå University of Technology, Sweden

Another structuring of the Living Lab is based on the social construction of technology (SCOT). This was developed by iLab.o in Belgium and suggests that technology is shaped by the user, highlighting the paramount necessity of investing social meanings into new technologies. Users are considered the central focus while facts and meanings are the results of social processes (Tuomi, 2002). This methodology consists of four phases (**Fig. *2***), from adoption of technology to the understanding of the meaning thereof (Ballon et al., 2005; Almirall et al., 2012).

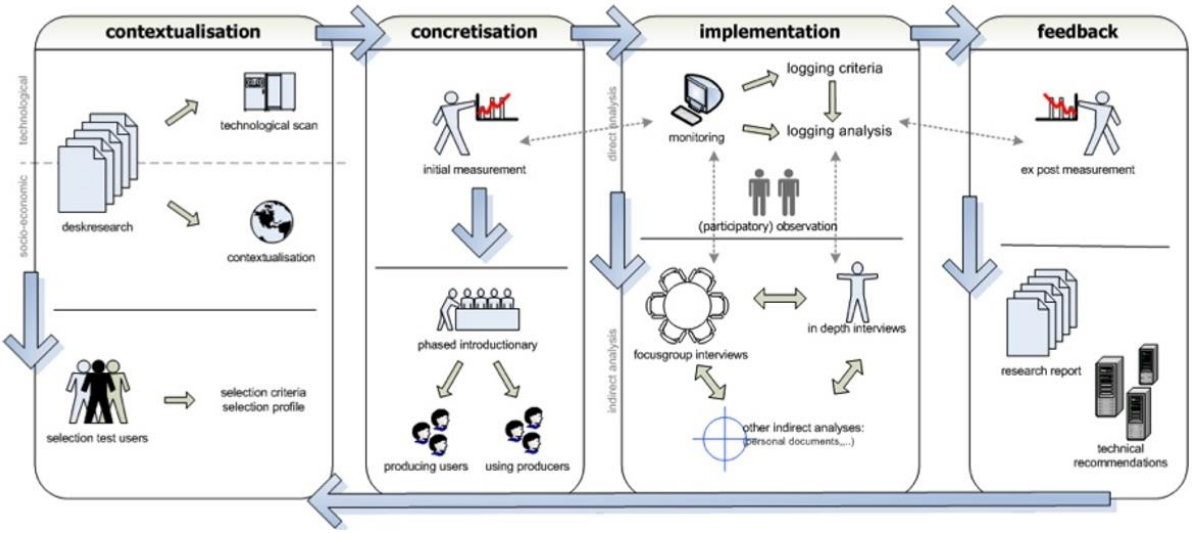

Fig. 2 iLab.o Living Labs methodology (Source: Almirall et al., 2012)

1. Contextualisation: this involves search of the relevant background on the research idea which information then informs the selection of user research partners of the Living Lab.
2. Concretisation: key in this phase is obtaining the initial state of the user panel, which information will later be used to evaluate the impact of the innovation post-introduction.
3. Implementation: here, the technologies are tested and validated. Actual measurements are undertaken on the devices or platforms being tested. Indirect measurements that capture meanings of the technologies and context to the users are also carried out using both ethnographic observations and qualitative analysis through focussed groups, and in-depth interviews.
4. Feedback: in this phase, results based on actual measurements are obtained. These are compared with those in the concretisation and implementation phases from which

conclusions and recommendations on the implementation of the technology are drawn.

The examples of living lab methodologies described above generally follow a similar iterative process, from efforts to find out ‘what is’ to implementation and re-evaluation as described by Ahmadi et al. (2020).

3.2. Adapting Living Labs to support gendered energy technology innovation

The case study of the GENS Living Labs was used to discuss how the concept of Living Labs can be adapted in gendered energy technology innovation. The GENS Living Lab is a part of a transdisciplinary project based on stakeholders with the major drivers being the community and their needs. The focus of these Living Labs is on fundamental and applied research in the security of household energy services with a gendered perspective. It is also a learning environment for researchers, key community leaders and the community in general. In GENS, our focus is on involving end users, the community, as active co-producers of value in the small-scale real-life testing and design environments, the households. This will allow us to achieve user centric and context specific energy security solutions for the households. These can then be further extrapolated to market and societal pilots to achieve highly visible, and more society embedded energy solutions. There are examples of operational energy Living Labs, for example, the energy Living Lab project in Switzerland (https://www.energylivinglab.com/project/ntn-innovation-booster-project/) that is focussing on energy decarbonisation projects, innovating from the bottom up with citizens and experimenting in a real-life setting in a public private people partnership. In France, the “Linky by Makers” (http://linkybymakers.fr/in-english/) supports user-driven innovation of the smart-meter program, Linky, of the French public electricity distribution network (PEDN). de Vries et al. (2016) while exploring user led innovations in Dutch civic energy communities found that the innovation dynamics of a community of technology users embed and co-evolve with community building providing a fertile ground for the implementation of user innovations.

In addition to the traditional way of looking at Living Labs (as innovation environments where to co-design solutions with multiple stakeholders), in the GENS project, Living Labs are also seen as socio-technical transition experiments. Drawing upon transition

studies, Ceschin (2014) described a socio-technical experiment as "*a partially protected environment where a broad network of actors can learn and explore (1) how to incubate and improve radical innovations, and (2) how to contribute to their societal embedding*". Such an environment presents strategic opportunities to create and grow to maturity highly risky and radical innovations without the direct pressure that characterises the mainstream market (Kemp et al. 1998). These experiments, just like Living Labs are implemented in real life settings, involving various actors, in a protected environment that allows creativity from all players (Baccharne et al., 2014; Ceschin, 2014). Our conceptualisation of Living Labs thus combines the traditional understanding of Living Labs elaborated in innovation management with the concept of socio-technical transition experiments. As a result, Living Labs can be defined as: a research and innovation concept for experimental and experiential learning in real-life environment, involving users and multiple private and public stakeholders, and aimed at: 1] co-designing, prototyping, testing, and observing new solutions and novel organisational structures in an iterative fashion; and 2] stimulating changes in the socio-technical regime to create the most favourable conditions for scaling-up of innovations.

Taking into consideration the proposed definition of Living Labs, and the scope of the project, GENS Living Lab can be defined as *a research and innovation concept for experimental and experiential learning in real-life environment, involving users and multiple private and public stakeholders, aimed at tackling the problem of energy insecurity in urban poor environments* through: 1] understanding attitudes, behaviours and gender roles in energy-related activities; 2] co-designing, prototyping, testing and observing new gender-informed energy innovations and related novel organisational structures; and 3] stimulating changes in the socio-technical regime in order to favour the scaling-up of these innovations as well as gender mainstreaming in the energy sector. As pointed our earlier, Living Labs are stakeholder driven.

4. Stakeholders in the Living Lab

Reed (2008) defined stakeholders as individuals, groups and organisations from the public that choose to play an active role in particular processes. However, sections of the public not active in the processes are stakeholders if they are affected in the process (Johnson et al., 2015). Working with stakeholders in the Living Lab improves acceptability, transparency, understanding, and adaptability to the processes and innovations within the Living Lab (Breukers and Wolsink 2007; Reed, 2008; Johnson et al., 2015; Mastelic et al., 2017; Gabriel

et al., 2020). In so doing, trust is built that eases adoption and maintenance of resultant innovations. It also enables social learning and may increase the dimensions considered in a particular decision, including "non-scientific" or "non-technical" inputs from the "lay" audience (Holmes & Scoones 2000; Glicken 2000). When people feel left out of the planning and decision-making process, chances of likely opposition to the process outcomes becomes high (Zoellner et al. 2008). In a large building energy management system, Mastelic et al. (2017) noted that involvement of all stakeholders from the start is crucial in reducing failure risks.

Living Labs are typically a collaboration of different stakeholders from different sectors. A structured review of literature on gender mainstreaming in the energy sector by Oosthuizen et al. (2020) revealed that participation of multiple stakeholders is an enabler, catalyst, and core element for the success and sustainability of gender mainstreaming. Stakeholders may include the public, policy, academia, commercial private sector, local communities, etc. that together aim at forming a network of excellence to achieve the desired outcomes of the Living Lab (Ahmadi et al., 2020). Through integration of expertise, experiences, and knowledge, participants cultivate a rich environment in which to mutually share, learn and co-create new solutions to a holistically comprehended problem or achieve shared and overarching goals (Ståhlbröst, 2013; Ahmadi et al., 2020). The stakeholder engagement process involves identifying supportive organizations and individuals at the outset and then building a trustful, common shared environment (Dupont et al., 2019; Ahmadi et al., 2020). One of the main challenges in stakeholder engagements is retaining the interest of the participants in practical research (Logghe et al., 2014; Ley et al., 2015), for example, profit-oriented companies within the Living Lab may continuously weigh the compromise between research and business objectives (Dachtera et al., 2014). Retention of participants involves careful planning of aspects like time, motivation, and interests of the different players to minimise the possibilities of withdrawal. For example, while studying the gendered practices in the IT industry, some women that were participating in the 'Feminist human-computer interaction Living Lab' dropped out due to time, own project constraints and being transferred to a different branch office (Ahmadi et al. 2020).

Effective and sustained stakeholder engagements call for a better understanding of the perspectives, concerns, and informational needs of the different groups within the collaboration and those affected by the process (Johnson et al., 2015). While analysing stakeholder power dynamics in a multi-stakeholder process, Brouwer et al. (2013) suggested

implementation of a collaborative leadership strategy among all stakeholders to ensure that the space they create remains power neutral. This they explained as one person (e.g., facilitator, convenor, chairman) being in charge, but create teams of stakeholders who together can 'balance the line' as real cord dancers. This helps to minimise conflict among stakeholders and puts more focus on the project goals. Introducing new stakeholders and interest groups along ongoing engagements may benefit the Living Lab by allowing in fresh ideas, and enlarge the scale of reach (Ahmadi et al., 2020). This exploits the flexibility and dynamism aspect vital in the Living Lab to continuously adjust its roles and actions (Ståhlbröst & Holst, 2017). Managers of the Living Labs need to be continuously reflective in order to adjust their process in response to the dynamic nature of studies in living social spaces (Ståhlbröst & Holst, 2017). Ahmadi et al. (2020) argued that longer stakeholder engagement time (three years and more in their case) enables more bonding between participants, methodological pluralism and enables cultivation and addition of diverse perspectives to the experience.

4.1. Types of stakeholders in the Living Lab

Mitchel et al. (1997) developed a widely cited framework that attempts to define different categories of stakeholders based on power, legitimacy, and urgency. These attributes vary based on the social construct of different societies. Johnson et al. (2015), adopting from Mitchel et al. (1997), defined 'power' in relation to stakeholders as "*the ability to bring about the outcomes one desires*", 'legitimacy' as "*those that have a legal, moral, or presumed claim"*, and 'urgency' as "*individuals or organizations that deserve immediate attention from the decision-makers*". Based on these attributes, Mitchell et al. (1997) defined the following categories of stakeholders.

(i) Definitive stakeholders: these have power, legitimacy, and urgency,
(ii) Dominant stakeholders have power and legitimacy,
(iii) Dependent stakeholders have legitimacy and urgency,
(iv) Dangerous stakeholders have urgency and power,
(v) Discretionary stakeholders have only legitimacy,
(vi) Dormant stakeholders are those with only power, and
(vii) Demanding stakeholders are those with urgency but lack power and legitimacy.

Defining categories of stakeholders in the Living Lab helps the managers of Labs to effectively plan and prioritise the often variant and competing stakeholder claims (Nyström et al., 2014; Ståhlbröst, et al., 2015; Johnson et al., 2015). A notion called stakeholder salience (Mitchell et al., 1997). In understanding the power dependencies, claims and roles of stakeholders in Smart City Living Labs Ståhlbröst, et al. (2015), found that the relation between the stakeholders and the Living Lab was mainly stakeholder dominant or mutually dependent, and rarely Living Lab dominant. This means that the survival of Living Labs are entirely dependent on the willingness of the involved stakeholders to continue collaborations and activities.

4.2. Stakeholder roles in the context of GENS Living Labs

The activities in the GENS Living Labs are a collaboration among different stakeholders including the government, non-governmental organisations, funding institutions, researchers, private companies, community radio station, co-researchers from the community, youth champions from the community, the community and community leaders (**Fig. *3***). These together are exploring current problems and solutions to sufficiently meet the energy needs in the community households. However, this list is in no way exhaustive as the Living Labs will be open to more collaborations from additional and different stakeholders. A further attempt is made to define some of the stakeholders' roles in the Living Lab bearing in mind that this may change from time to time owing to the dynamic nature of living labs. While dealing with stakeholders in Living Labs in the energy field, Dupont et al. (2019) pointed out the technical and abstract nature of energy and electricity systems. These technicalities may limit willingness of less technical actors to partake in issues that can quickly become technical or at least require specialists' assistance. The authors suggested putting greater effort in communication, vocabulary creation and shared representations (Dupont et al., 2019).

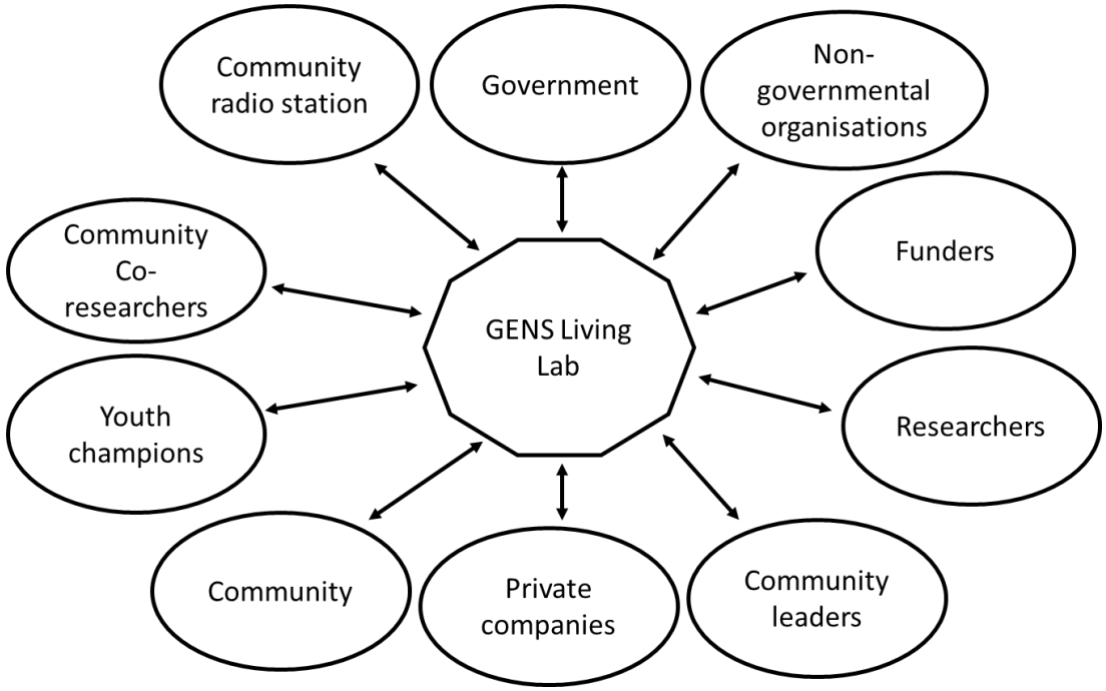

Fig. 3 Rational map of the Gender for Energy security (GENS) Living Lab stakeholders

The community: To work with the identified poor urban community, Groenheuwel, in the South African case study, a partnership was formed with a community radio station (Radio KC). The community radio has trust and access in the target community owing to previous projects it had done or partnered within the community. Through the management of the radio station, community co-researchers were recruited and trained using the community Primary school (Groenheuwel Primary School) as the base for the community activities. Together with the radio and the trained co-researchers, a non-random probability sample of households representing a diversity of households in the community was identified. This included brick-built households, wooden and metal shacks as well as backyard house dwellers. A quantitative survey conducted by trained community co-researchers (face to face interviews) assessing the security of household energy services in eight sections of the community in October/November 2020 and an ethnographic follow up study in 20% of those households in March 2021 will help assess the household energy gaps within the community (Mukama et al. (submitted)) for which solutions will be sought in collaboration with the community and other stakeholders in the GENS Living Lab. In particular, the survey sought to understand how different members within the household, male and female are impacted by energy issues, in terms of expenditure on energy with respect to income, the fuels used, the devices used, and the different services to the households using the available fuels and

devices. The project will further seek and value local knowledge and input from the community members in the process of design of alternative household energy devices and services to improve the security of energy services within their households. Open social innovation is the best strategy for social enterprises to progress and grow operations (Yun et al., 2017). Based on the classification of stakeholder types by Mitchell et al. (1997) described in section 4.1, the community members can be generally classified as *definitive* stakeholders because they are legitimate, have power to impact the success of the project, and are in urgent need of interventions towards household energy security. However, not all community members have the power, legitimacy, and urgency in terms of energy needs and may fall in any other of the categories of stakeholders.

Government/Policy: The government's role in Living Labs can be two-fold, (i) promote and enable the development of Living Labs, and (ii) develop policies that encourage the demand of products and services that emanate from Living Labs (Almirall et al., 2012). The public sector and local government players will guide the activities of the Living Lab in line with the governing laws and champion instances where the law may need amendment for the public good. The public sector in this case can be categorised as a *dominant* stakeholder given, they have power and legitimacy but may lack the urgency in terms of the desire to solve the community energy needs probably due to a multitude of other tasks and demands of the community. While building a working relationship with the community, working with especially the local government is important as they have the power to stop or halt any activities, they may feel alienated from within a particular community (Johnson et al., 2015). Favourable social innovation policies to social problems draw strong impetus from support of top political decision makers and government agencies that work on societal problems (Yun et al., 2019).

Industry partners (private companies): Partners and technocrats especially in the household energy sector will play a paramount role within the GENS Living Labs. They will champion the design of energy technologies in real life settings, allowing understanding of user contexts and emergence of new meanings and uses (Almirall et al., 2012). Local and international energy companies and manufacturers are invited to partake in this initiative commercially and as a social responsibility. The industry partners have the power to innovate and market their technologies, have a legitimate claim on the innovations, and may have urgency to implement in the particular study community, in this case, they fall under the *definitive* stakeholder category.

Researchers: Researchers will manage and co-lead most activities in the Living Lab. They will play the lead role in knowledge creation and seek funding for the activities of the Lab. They are expected to be flexible in terms of the methods employed and their role in the Living Lab (Ahmadi et al., 2020), and reflective (Ståhlbröst & Holst, 2017). The researchers will however be expected to remain objective and remove any individual biases from the study. Dedication, care and showing empathy with the research subjects builds trust and confidence that enriches the outcomes of the study (Ahmadi et al., 2020). Researchers will also be expected to provide sufficient infrastructure and tools to comfortably work with the study participants. Researchers in this context can be viewed as *dependent* stakeholders as they have the legitimacy and urgency but lack power to impose their developments or innovations on the community. They can only play a persuasive role in this scenario using evidence-based knowledge and information.

Funders: The GENS activities in the Living Lab will need more monetary resources in addition to research funding from the National Research Foundation and the Newton Fund through the British Council. The funding will facilitate training and facilitation of community co-researchers and youth champions as they carry out community work towards attainment of the GENS Lab objectives. The funders in this case may fall in the category of *dormant* stakeholders with power but may lack legitimacy and urgency.

If all these stakeholders and more that will join the GENS Living Labs commit to the task at hand, we believe the household energy security in Groenheuwel will improve and act as a model for other similar communities on the African continent and beyond.

5. Conclusion

This paper contributes to the theory and practice of Living Labs in the energy sector and how this concept is applied in the GENS Living Lab within the GENS Trilateral Research Chair. The GENS Living Labs is collaborating with multiple stakeholders in co-researching, co-designing, co-creating, prototyping, and testing gendered energy innovation and commercialisation opportunities in alternative energy technology and services. The study specifically explored three research questions (i) What are the typologies of the concept of Living Lab in the literature? (ii) How can the Living Lab concept be adapted to support the gendered energy technology innovation in poor urban environments? (iii) What are the behaviours expected of stakeholders influencing gendered energy technology innovation in the Living Lab and what are their potential roles in the context of GENS Living Labs?

The study found that although defined differently by different scholars, Living Labs have common characteristics, including implementation in **a real-world setting**, with real users in real-life situations. Activities are based on **user-centred**, **co-design** and **participatory** approaches, designing, prototyping, and testing solutions with **multiple stakeholders**, including users, researchers, industries, NGOs, policymakers, experts, etc. This will be the approach adopted by the GENS project, combining the traditional understanding of Living Labs elaborated in innovation management with the concept of sociotechnical transition experiments. Stakeholders affect or can be affected differently by a particular project. In this review, an attempt was made to describe the different stakeholders and the different roles/impacts they will have on the GENS project. We recommend further use of Living Labs approach in the energy sector to benefit from the collaborative approach and diverse knowledge amalgamation from the multiple stakeholders typical in such settings. At the end of such projects, local ownership is paramount for the continuity of the benefits therefrom. The paper is of benefit to the energy researchers, energy policymakers, urban development practitioners and planners, not only on the African continent but also in other developing countries, to design Living Labs dealing with gender and energy insecurity in poor urban environments.

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